REMARKS

Claims 6-13 are presently in the application. Claims 1-5 have been canceled.

The examiner's indication of allowable subject matter in claims 10 and 11 is greatly appreciated. Claims 10 and 11 have been rewritten in independent form, including all of the limitations of the claims from which they originally depended. Thus, claims 10 and 11 are now in allowable condition.

Reconsideration of the rejection of claims 6-9 under 35 USC 103(a) as unpatentable over Cavanaugh et al in view of Rao ('919) and the rejection of claims 12 and 13 under 35 USC 103(a) as unpatentable over Cavanaugh et al in view of Rao ('919) in combination with Guernert (DE '004) is respectfully requested.

Applicant's invention is directed to a tribological system comprising a piston, a cylinder wall and **fuel** as lubricating fluid. Specifically, applicant teaches a radial piston pump wherein the outer jacket face (3) of the pump pistons and/or the inner jacket face (20) of the element bores in which the pistons reciprocate are formed with lubricating structure in the form of conduits or channels in the μm range. The conduits or channels formed on the piston jacket face and in the element bore can be embodied very smoothly and accurately in terms of shape. As a result, very small play is attainable, which especially at high pressures, because the gap losses are so slight, leads to good efficiency of the radial piston pump. The conduits or channels on the surface of the pistons and/or of the element bores has the function of lubricant pockets and lubrication conduits. As a result of applicant's invention, the

lubricant medium, namely fuel, is distributed during operation to the lubrication points to be supplied along the running paths. At the same time, the structure acts as a reservoir for the lubricant medium.

Claim 6 calls for a radial piston pump having a driveshaft, supported in a housing, that has an eccentrically embodied shaft portion which cooperates with preferably a plurality of pistons capable of reciprocating radially, relative to the driveshaft, in a respective element bore, in order to aspirate **fuel** and subject it to high pressure in a high-pressure region, wherein the outer jacket face (3) of the pistons and/or the inner jacket face (20) of the element bore have a structure in the µm range formed therein. Claims 8 and 9 specifically call for the structure in the µm range to comprise channels (4-8), which extend in the circumferential direction.

Rao's disclosure is concerned with a piston for an internal combustion engine, the piston having a skirt, wherein the piston is oil-lubricated, rather than fuel-lubricated. Since oil must not enter the combustion chamber of the engine, there are one or more piston rings to wipe the oil from the cylinder walls (see, oil ring grooves 43 in Fig. 2), thus, preventing oil from entering the combustion chamber of the engine. Rao also describes a solid film lubrication (SFL) comprising graphite and molybdenum disulfide in a resin deposited on the piston specifically chosen to attract oil. At col. 4, lines 4-13. Rao teaches that:

> This invention coats the piston skirt with a novel solid film lubricant 44 (see FIG. 8) that attracts oil and uses such attracted oil to maintain low-frictional characteristics contributed by the solid ingredients. The

> solid film lubricant is locked in place on such surface, polished, and dimpled to create pockets for oil film replenishment. In addition, the piston skirt is modified to provide relief areas around lands supporting the solid film lubricant to reduce the interfacing area of the piston with the bore wall.

Specifically, Rao teaches a low-friction piston for use in an **oil-fed** cylinder bore wall having relieved areas 30, 31, 32, 33 of a depth of about 20-30 microns (col. 4, lines 14-17) and lands 35, 36, a SFL coating 44 deposited "only onto such lands" (col. 4, lines 33, 34) to a thickness 47 of 10-35 microns. Prior to deposit of the coating 44 on the lands, Rao teaches that the lands 35, 36 are provided with "a predetermined pattern of asperities 49" (col. 5, lines 34, 35). The coating is sprayed onto the lands, polished and then shallow pockets 55 are formed at the asperity mouths 56 (Fig. 12). The resin used in the SFL is selected with special characteristics for attracting an oil film to fill the piston-bore wall gap (col. 1, lines 66, 67 and col. 2, lines 16-19).

In the rejections, Cavanaugh et al is cited to show a pump plunger 1004 (Figs. 44 and 45) having first and second annular lubrication grooves 1040 and 1042 connected by cross passage 1044. See col. 44, lines 2-4. Cavanaugh neither teaches nor suggests that the lubrication grooves 1040 and 1042 and cross passage 1044 are formed in the μm range.

The examiner describes Rao as teaching lubrication grooves in a piston as small as 5 microns in order to hold lubricant for lubricating the piston within the piston chamber. Of course, Rao teaches much more than this.

The examiner's rejection of claims 6-9 concludes with the following statement:

> Applicant's limitation of a <u>micron range</u> has not been rejected as vague (under 35 USC 112, second paragraph) but merely broad and thus the disclosure of 5 microns in Rao teaches his range and would have made obvious the claimed depth for the channels of Cavanaugh.

(Emphasis original).

Thus, as best understood, the examiner has concluded that it would have been obvious to make Cavanaugh's lubrication grooves 1040 and 1042 and cross passage 1044 in the micron range as taught by Rao.

There are a number of reasons why one of ordinary skill in the art would <u>not</u> have been instructed to form Cavanaugh's lubrication grooves 1040 and 1042 and cross passage 1044 in the micron range based on the teachings in Rao.

First, Rao is directed to a reciprocating piston for an internal combustion engine wherein the piston is oil-lubricated, rather than fuel-lubricated. The pump plunger 1004 in Cavanaugh is fuel lubricated and is used in a pump, not in an internal combustion engine, of a system for supplying high pressure fuel in the 5000 psi to 30,000 psi range to an engine. There is no teaching or suggestion in Rao that the piston used in an oil-fed cylinder bore wall disclosed therein is suitable for use in a pump of a system for supplying high pressure fuel in the 5000 psi to 30,000 psi

range as required by the pump structure disclosed in Cavanaugh. In fact, it is applicant's specification that provides the only teaching of a radial piston pump wherein the outer jacket face of the pump pistons and/or the inner jacket face of the element bores in which the pistons reciprocate are formed with lubricating structure in the μm range.

Second, it is not the shallow pockets 55 at the asperity mouths of Rao that lead to an improved behavior of Rao's piston. Rather, it is the SFL coating on the lands with the shallow pockets in conjunction with the undercut regions which provide the improved behavior. Once again, there is no teaching or suggestion in the prior art that an SFL coating on lands with the shallow pockets in conjunction with undercut regions is applicable to pistons in a radial piston pump used to supply high pressure fuel to an engine.

Third, Rao describes a piston surface structure comprising shallow pockets of about 5 microns depth and undercut regions with an additional depth of 20 to 30 microns. The piston-cylinder bore clearance described by Rao is in the 5 to 20 micron range (see col. 8, line 38), which is far more than the clearance between a piston of a radial piston fuel pump and its cylinder wall. Thus, the teachings in Rao could not be used in a piston pump of the type disclosed in Cavanaugh.

Finally, the size of a piston of an internal combustion engine (approx. 70 to 100 mm) and the size of a piston of a high pressure pump (5 to 7 mm) of the type

disclosed in Cavanaugh makes it impossible to simply transfer the depth of the structures at the surface of the piston or cylinder wall from one to the other.

The test for obviousness is what the combined teachings of the prior art would have suggested to one of ordinary skill in the art. See, for example, In re Keller, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). In establishing a prima facie case of obviousness, it is incumbent upon the examiner to provide a reason why one of ordinary skill in the art would have been led to modify a prior art reference or to combine reference teachings to arrive at the claimed invention. See Ex parte Clapp, 227 USPQ 972, 973 (Bd. Pat. App. & Int. 1985). To this end, the requisite motivation must stem from some teaching, suggestion or inference in the prior art as a whole or from knowledge generally available to one of ordinary skill the art and not from the applicant's disclosure. See, for example, Uniroyal, Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 1052, 5 USPQ2d 1434, 1052 (Fed. Cir.), cert. denied, 488 U.S. 825 (1988). The mere existence of individual features in the prior art is not in itself sufficient basis to render a claimed invention obvious under 35 USC 103. Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 1548 220 USPQ 193,199 (Fed. Cir. 1983).

In other words, to establish a prima facie case of obviousness, the examiner must show some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. There is no suggestion to combine, however, if

a reference teaches away from its combination with another source. "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant . . . [or] if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the applicant." In re Gurley, 27 F.3d 551, 553, 31 USPQ2d 1130, 1131 (Fed. Cir. 1994). If when combined, the references would produce a seemingly inoperative device, then they teach away from their combination. In re Sponnoble, 405 F.2d 578, 587, 160 USPQ 237, 244 (CCPA 1969); see also In re Gordon, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (finding no suggestion to modify a prior art device where the modification would render the device inoperable for its intended purpose).

Also, in order to rely on a reference as a basis for a § 103 rejection of an applicant's invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned. In re Oetiker, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992).

In this case, the examiner has failed to set forth a valid motivation for combining the teachings in Rao with those of Cavanaugh. The only motivation set forth in the grounds of rejection is that it was well known in the art, as evidenced by Rao, to use lubrication grooves in a piston as small as 5 microns in order to hold

lubricant for lubricating a piston within its cylinder. However, as pointed out above, the mere existence of individual features in the prior art is not in itself motivation sufficient to render a claimed invention obvious. Applicant's claims are directed to a radial piston pump, not an internal combustion engine, which is disclosed in Rao. There is simply no motivation for taking the teachings involving piston structure of an internal combustion engine, which is oil fed and has a skirt, and applying it to a piston in a fuel pump of the type disclosed in Cavanaugh, which is fuel lubricated and has no skirt.

It is emphasized that Cavanaugh does not teach an improved lubricating system composed of lubrication grooves in a piston wall as small as 5 microns as suggested by the examiner. This is an extreme over simplification of the teachings in Rao. As indicated above, Rao actually teaches that it is the SFL coating on the lands with the shallow pockets in conjunction with the undercut regions provided on the piston skirt which provide the improved behavior. The examiner cannot simply pluck from Rao's disclosure the concept of micron sized depressions and ignore all of the other teachings found in the reference.

Further, one of ordinary skill in the art would not have combined the teachings of Cavanaugh and Rao in the manner suggested by the examiner, because the resulting piston structure would have rendered the fuel pump in Cavanaugh inoperable for its intended purpose. This is so because the piston-cylinder bore clearance described by Rao would render the piston fuel pump of Cavanaugh

inoperative. The teachings of Rao cannot be used in a piston pump of the type disclosed in Cavanaugh.

Still further, Rao's teaching is exclusively concerned with piston structure for use in an oil-fed cylinder bore with the piston skirt relieved to define lands that are coated with SFL specifically chosen to interact with an oil lubricating medium and having an ultimate goal of reducing the length of the piston's skirt (see, col. 3, line 38 to col. 4, line 3). Oil-lubricated internal combustion engine piston design is not within the field of applicant's endeavor, i.e., radial piston fuel pumps. In addition, the problems associated with cylinder bores and pistons in internal combustion engines, which are oil-lubricated, are so different from the problems associated with tribological systems in radial piston fuel pumps, which are fuel-lubricated, that there is no reasonable pertinence between the two fields. Thus, Rao constitutes non-analogous art which may not be relied on in a proper § 103 rejection.

For the reasons set forth above, claims 6-9 are not rendered obvious in view of the teachings of Cavanaugh and Rao.

In the rejection of claims 12 and 13, the examiner adds the Guernert reference, which is discussed on page 1 of applicant's specification. Guernert teaches a radial piston pump having a <u>macroscopic</u> annular groove (2) which communicates with a plurality of axially disposed <u>macroscopic</u> conduits (3, 4, 5) formed in the outer jacket face of the piston. There is no teaching or suggestion in Guernert of forming the groove and conduits in the μm range. If anything, Guernert

teaches away from the use of μm range structures on the outer jacket face of the piston. Thus, Guernert does not solve the basis deficiencies in the teachings of Cavanaugh and Rao.

In accordance with the foregoing, applicant respectfully requests that the examiner reconsider and withdraw the outstanding rejections. If, however, the examiner feels that any further issues remain or require clarification, the examiner is cordially invited to contact the undersigned in order that any such issues may be promptly resolved.

Attached herewith is a One-Month Extension of Time.

Respectfully submitted,

Date: February 5, 2004

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